A Decision Support System for an Optimal Transportation Network Planning in the Third Party Logistics

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ABSTRACT

In an effort to gain competitiveness, recently many companies are trying to outsource their logistics activities to the logistics specialists, while concentrating on their core and strategic business area. Because of this trend, the third party logistics comes to the fore, catching people's attention, and expanding its market rapidly. Under these circumstances, the third party logistics companies are making every effort to improve their logistics services and to develop an information system in order to enhance their competitiveness. In particular, among these efforts one of the critical parts is the decision support system for effective transportation network planning. To this end, this study has developed an efficient decision support system for an optimal transportation network planning by comprehensively considering the transportation mode, routing, assignment, and schedule. As a result of this study, the new system enables the expansion of the third party logistics companies' services including the multimodal transportation, not to mention one mode of transportation, and also gets them ready to plan an international transportation network.

I. Introduction

In an effort to gain competitiveness, recently many companies are making efforts to concentrate their limited management resources on the core businesses, while outsourcing non-core logistics activities to the logistics specialists. Here the outsourcing of logistics activity can be defined "third party logistics." The CLS (Council of Logistics Management) of the USA defines third party logistics (3PL) as a firm or an agent who provides outsourced logistics services to its client company in the logistics channel on a short term or long-term relationship basis, and so the owner of goods (the client company) makes an agreement with one or plural logistics specialists on a specified terms and conditions for a certain period time. Therefore, it is also called "contract logistics"[4]. Meanwhile, a lot of researchers are emphasizing the importance of 3PL. Cantiz (1996) said in his paper that it is not easy for a company to gain a proper return of its investment in the logistics field, and that the best solution is to make use of the third party logistics company who can provide some or all of supply chain management function [3]. Concerning the motive of many companies' logistics outsourcing, Baghi & Virum (1998) pointed out that it is because of the reduction of market size, increasing global competition, shortening product life cycle, excessive costs, the necessity of speedy and smooth customer service, and decreasing profitability [1]. Park Chan-Seok (2002) stressed in his research that the third party logistics, in addition to its main function of performing logistics activities, is conducting a very critical function of SLO (Strategic Logistics Outsourcing), which includes the client company's planning function [13].

It is noteworthy that 3PL is rapidly growing because of the trend that the business activities between companies are moving from the existing transaction-oriented to the relationship-oriented [6]. In particular, many US and European companies, the leaders in the logistics field, are widely taking advantage of 3PL in terms of a strategic viewpoint. In case of the USA, in 1995 the usage rate of 3PL is 60%, and in case of European countries, it amounts to 76% [7]. From then on it has continued to grow. Western Europe reaches 72%, Asia 63%, Mexico 60%, and Canada 50% [8]. Meanwhile, the market size of the logistics field also continues to grow. In the USA, the logistics market size in 1991 grew to be US$ 6 billion, US$ 16 billion in 1994, US$ 39.6 billion in 1998, and US$ 50 billion in 2000, thus showing a growth rate of 20% per year, and continually being expected to grow.

In case of Korea, third party logistics is still in the beginning stages, and its market size stands at 3 trillion won, quite small compared to the international logistics market [10]. According to the survey of "Domestic Companies' Logistics Management Reality in 2001" (Dec. 2001) conducted by the Korea Chamber of Commerce and Industry (KCCI) with the survey objects of 603 manufacturers and distributors, and also the survey of "Reality Check on the Usage of 3PL of Domestic Traders," which was also conducted by the secretariat for shippers of KCCI (July, 2002) with the survey objects of 100 member traders, increasing companies are taking advantage of 3PL in order to obtain the specialist knowledge and to save costs [15]. Also more companies, which have a relatively higher weight of logistics compared with that of foreign companies, are trying to transfer its logistics activities to the logistics specialist, while concentrating their resources on the key parts such as business, marketing, and production. As a result of this trend, the 3PL market is expected to be brighter.

However, along with the promising growth of 3PL market, its competition is also being intensified. Because of this, third party logistics companies have to take measures to strengthen their competition. As a way of offering specialized services, some researches are focusing on the introduction of a new information system. Londe & Maltz (1992) said that the purpose of outsourcing logistics was to obtain the differentiation of services rather than cost saving, while emphasizing the importance of a differentiated service. Ahn Young-Hyo explained in his study that many third party logistics companies are aggressively trying to invest in obtaining up-to-date information technology, and some of them are making a strategic alliance with an IT specialist in order to establish a new information system [14]. Bradley (1994) emphasized the importance of a unique information system to take the lead in providing 3PL services to the client companies [2]. In an effort to activate domestic 3PL services, Lee Chung-Kyu, et al. (2002) have stressed the importance of logistics information system, while pointing out the necessity of specialized service models and strategies [15].

For this purpose, this study has developed a new system, TNPS (Transportation Network Planning System), which can be of great help for 3PL's transportation network planning. Even now, most 3PL companies are depending upon the experiences and existing practices of the persons in charge in planning their transportation network, gathering information by means of a telephone and a facsimile, and consequently causing problems in terms of efficiency and cost. These problems include the following: First, the transportation network planning is manually made, based on the know-how of the persons in charge. Secondly, after completion of transportation network planning, it presents to the shipper only the results such as transportation costs and transportation period, not suggesting its generation process or alternatives, consequently giving the client company no opportunity to select a better alternative. Thirdly, it is impossible to systematically gather the know-how, data, and knowledge about transportation network planning. Even worse, the increasing number of client companies and rapid expanding cargo volume makes it almost impossible to manually perform its transportation network planning.

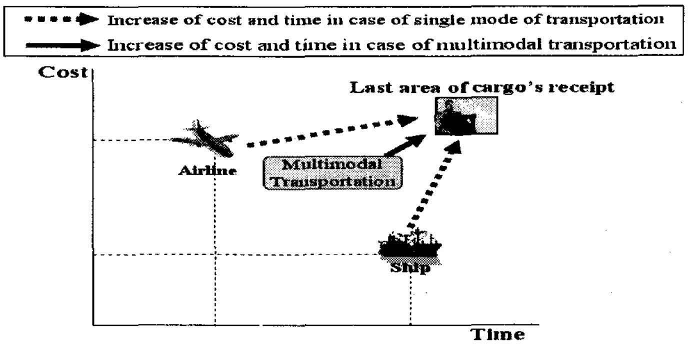
Therefore, in order to generate an optimal transportation network, the user's opinion should be successively reflected, so that the user can make a better decision. To this end, the decision support system is vitally necessary. In this respect, the TNPS developed by this study can be of great help for the solution of many problems inherent to the existing planning method. More importantly, the diverse transportation network and evaluation materials generated by this new system can build confidence in the client's mind, eventually improving relationships with the shippers. In particular, it is noteworthy that the business transaction in the 3PL is characterized by its relationship-oriented feature.

II. Optimal Transportation Network Planning

In dealing with the problem of an optimal transportation network, this study has adopted the systematic approach instead of using an algorithm. Most researches using an algorithm approach are focusing on generating an optimal transportation network. However, this study judges that an optimal transportation network is selected not by a system, but by a user. So based on this judgment, this study has focused on providing diverse evaluation materials on transportation network, so that a user (a shipper) can easily select an optimal transportation network. That is to say, instead of approaching the problem of transportation network by way of optimization, this study has approached the problem by means of a decision support system. In general, when a system has suggested an optimal alternative to the user, the user has a tendency not to follow as suggested, and so it is very difficult to generate an optimal alternative fit to the user's requirements. In particular, in case of transportation network, various factors such as cost, time, and service should be considered simultaneously. Because of this, it is more difficult to generate an optimal alternative fit to all the users.

These characteristics are well revealed in the user's requirements survey. As the system in this study is a new system that has not yet developed and commercialized, we has made a thorough survey of user's requirements. The user's most common requirement is that instead of receiving a transportation network considered to be an optimal one, they want diverse alternatives as well as objective evaluation materials, so that they themselves can select the best alternative. Users judge that this method is not only useful to their business, but also makes a great contribution to the mutual relationship improvement. The objective evaluation materials for transportation network make it easy to gain access to the shippers for business, and also build confidence in the client's mind.

Meanwhile, in generating a transportation network, this study has considered a multimodal transportation network, not to mention the single transportation mode. Thanks to the appearance of containers, various kinds of transportation modes can be easily connected. In addition to this, automation in cargo handling has brought the rapid development of multimodal transportation network, which enables the linkage of diverse modes of transportation by land, sea, and air [12]. In particular, recently customers request a door-to-door delivery service. Therefore, to make a response to customer's demand, 3PL has to perform multimodal transportation services. Park Young-Tae (2001) said that the most important characteristics of leading 3PL companies in the USA and Europe are the diversification of their logistics services, and expansion of service areas in their efforts to take the lead in competing globally [11]. This means the necessity of multimodal transportation. However, in reality, most domestic 3PL's are making their transportation network planning, depending upon "Shipping Gazette," "Schedule Bank," and other schedule materials provided by shipping companies or airlines. But those materials include the schedule for only single mode of transportation, not for multimodal transportation. Therefore, it is very difficult to prepare multimodal transportation network planning. For example, sea transportation costs less, but takes longer. Air transportation costs more, but takes shorter. If a customer requests a mid-level service of sea transport and air transport, the 3PL will have to provide a multimodal transportation service. As shown in the <figure 1>, by using a multimodal transportation service, cargo delivery can be made faster than sea transportation, and cheaper than air transportation. In conclusion, in dealing with the problem of transportation network planning, this study is characterized by the adoption of a decision support system approach and transportation network planning based on multimodal transport.



<Figure 1> Necessity of multimodal transportation

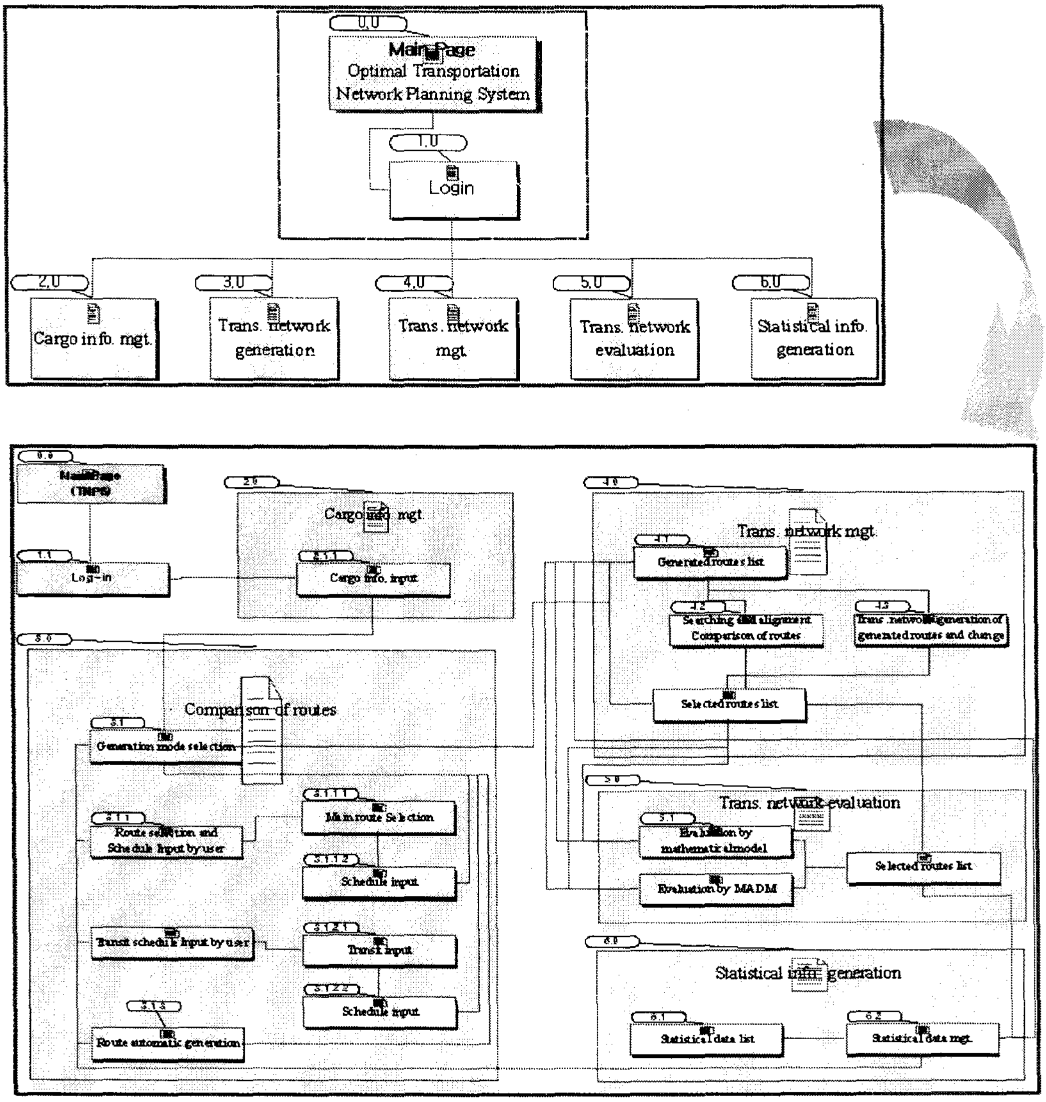
III. Decision Support System for an Optimal Transportation Network Planning

1. System Structure

Our new system TNPS (Transportation Network Planning System) enables 3PL companies to consider transportation mode, routing, assignment, and scheduling comprehensively, so that its client can select an optimal transportation network by means of reciprocal action with the system. The system selects the proper transportation mode on the bases of the feature of customer's cargo, taking into consideration multimodal transportation in addition to single mode of transportation. When presenting to the customer all the possible transportation network, it suggests only available ones after considering all the schedules comprehensively. In addition, the time and cost of all the transportation networks are automatically calculated, thus making it possible to assign customer's cargo efficiently.

<Figure 2> shows the structure of the whole system of TNPS. This system is composed of five modules: cargo information management, transportation network generation, transportation network management, transportation network evaluation, and statistical information generation. The cargo information management module is to receive and manage information, the transportation network generation module is to generate all available transportation networks, and the transportation network management module enables a customer to search, align, compare, and analyze all the available transportation networks generated. That is, based on the route, cost, time, and transportation mode that the customer wants, this module enables him to select an optimal network. The next step is to evaluate the transportation networks selected by the customer. In this stage, the customer can evaluate all the transportation networks generated or only the transportation network that he has selected. The transportation network evaluation module is to do the evaluation function. For evaluation, this study has used both the evaluation by mathematical model and evaluation by MADM (Multi Attribute Decision Making) methodology. Finally, the statistical information generation module is to use all the information accumulated from the usage of

the system over a long period of time and to generate diverse statistical information.



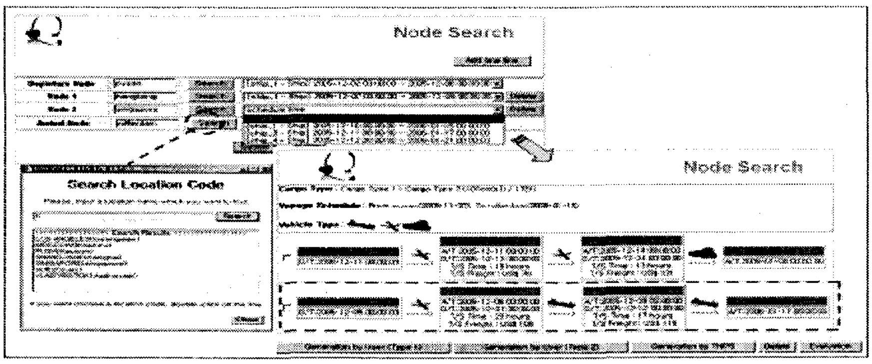
<Figure 2> Structure of TNPS

If a lot of customers use this system over a long period of time, the statistical information such as the usage situation of many transportation networks and transportation network selection situation based on cargo type can be accumulated and generated. And these data can be useful information on international transportation market situation. Among these five modules of TNPS, the critical ones are the transportation network generation and the transportation network evaluation. It is because the key functions of TNPS are to generate the transportation network for customer's cargo delivery and to provide a customer with the evaluation information on the generated networks.

2. Transportation Network Generation

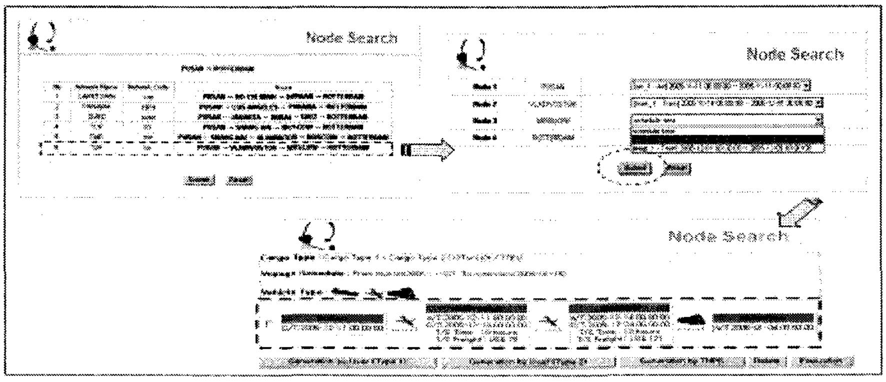
In generating the transportation network for customer's cargo, TNPS can provide a variety of methods according to the degree of expertise on transportation network planning. This idea has come from the user's survey. According to the survey, most users have wanted diverse functions suitable to the user's level instead of a one-sided function. Considering user's requirements, TNPS has adopted the following three methods to generate the transportation networks: transit place and schedule determination mode, schedule determination mode by route, and automatic generation mode.

If a user has much knowledge and experiences on transportation network planning, so that he knows about the transit places and routes of the cargo delivery, or if a customer requires a specified transit place, then the transit place and schedule determination mode are to be used. As illustrated in the <figure 3>, the user can search and select the transit place he wants in the upper side of the screen, and then if he selects the schedule of the corresponding transit place, the transportation networks are to be generated as shown in the lower right side of the screen.



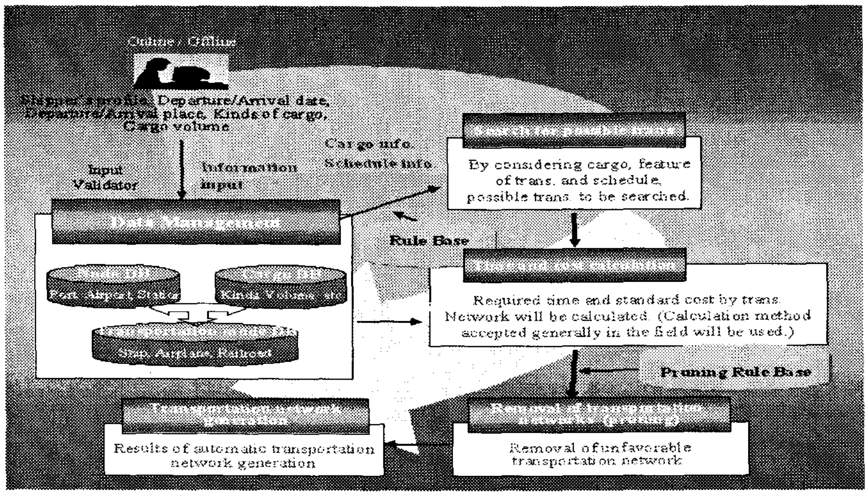
<Figure 3> Transit place and schedule determination mode

The schedule determination mode by route can be used for the user who has not enough knowledge and experiences but has some knowledge of transportation routes. In this case, as illustrated in the upper left side of the screen of below <figure 4>, the routes for cargo transportation are to be automatically generated, and the user can select one of them to find out available schedules. If he selects the schedule he wants, he can gain the transportation network as shown in the lower part of the screen. Of course, the user can select multiple routes and ensuing schedules.



<Figure 4> Schedule determination mode by route

Finally, the automatic generation mode is to be used for a beginner who has little knowledge and experiences. Based on only cargo information, he can generate all possible transportation networks from the system. <Figure 5> shows the process of automatic transportation network generation from the system. However, as this system is to consider multimodal transportation network, the user, first of all, has to judge which transportation mode is possible for the customer's cargo. By using "if-then" pattern knowledge, the user can select all possible transportation modes, and based on this, transportation networks are automatically generated. In case that the weight and size of cargo is too heavy and too big, it is not suitable to air transportation. Accordingly, air transportation is automatically dropped out from the available transportation network generation.



<Figure 5> Process of automatic transportation network generation

The time and cost for generated transportation networks is to be calculated automatically, and cost accounting has been based on the calculation method generally accepted in the field. For instance, in case of sea transportation, the following formula has been used:

(Number of containers x rates*) + surcharge (oil, currency, etc.) + incidental expenses

* Rates: freight by area (ex: North America – US$1,300 per 20ft.)

The transportation networks generated based on the cargo information alone can include some unreasonable transportation networks. Therefore, these kinds of networks are required to be removed. For this purpose, this study has introduced the pruning rule. That is, by using the pruning rule, the unfavorable transportation networks and schedules in terms of cost and time can be eliminated. The pruning rule adopted in this study is as follows:

If there are two arcs of "k" and "l" in one node (n), the transport cost (C) and transport time (T) comprise of one pair (C_n^k , T_n^k) and (C_n^l , T_n^l). Also, if one is in a dominant position, the other arc will be eliminated by the pruning rules. The pruning rules are as follows.

- *Rule 1.* The arc with a higher cost and time in one node will be eliminated.

If $C_n^l > C_n^k$ *and* $T_n^l > T_n^k$, (C_n^l, T_n^l) is eliminated by (C_n^k, T_n^k)

- *Rule 2. If the cost of both arcs is the same in one node, but the time taken is different, then, the arc with the longer time is eliminated. Also, if the time taken is the same, but their cost is different, the higher cost arc is to be eliminated.*

If ($C_n^l = C_n^k$ *and* $T_n^l > T_n^k$) *or* ($T_n^l = T_n^k$ *and* $C_n^l > C_n^k$), (C_n^l, T_n^l) is eliminated by (C_n^k, T_n^k)

- *Rule 3. If an arc in a node has an arrival date later than the latest departure date, it is to be eliminated.*

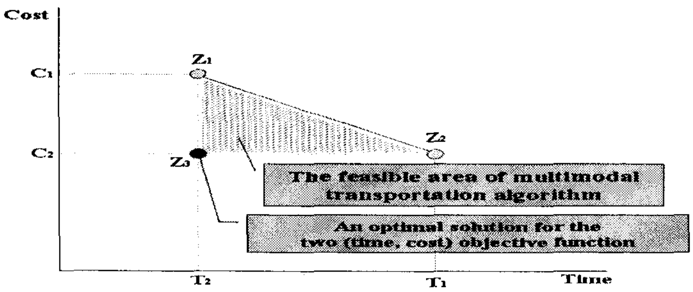
$\max(S_n^{\delta^+}) < (A_n^{\delta^-})$

If there is a departure arc (δ^+) and arrival arc (δ^-) in a node, and the departure time of the departure arc is represented as $S_n^{\delta^+}$ and the arrival time of the arrival arc is represented as $A_n^{\delta^-}$, the arc $A_n^{\delta^-}$ is larger than the maximum value of $S_n^{\delta^+}$ so it is to be eliminated.

3. Transportation Network Evaluation

In order to evaluate the generated transportation networks, TNPS has introduced two kinds of evaluation methods – evaluation by mathematical model and evaluation by MADM methodology. Time and Cost is the two critical factors in evaluating the transportation networks. In this case, if the user selects the network that he wants based on a single factor, it is not difficult. What he has to do is put the networks in order. But if he has to integratively consider the two factors – time and cost, or if he has to consider additionally the service factors such as port service level and agent's capacity, he needs an additionally evaluation method. In this study, we haves adopted an algorithm for integrative consideration of time and cost, and an MADM for evaluating other factors including a service.

As illustrated in the below <figure 6>, the effective area in the shade can be drawn as a way of considering time and cost integratively. The solutions in the effective area can be alternatives for an optimal transportation network. That is, the Pareto solution, an optimal transportation network, can be found in the effective area.



<Figure 6> Effective area of mathematical model

In order to determine the effective area, the function with the goals of least cost and shortest time can be used to discover the point Z1 and Z2, and the intersection of these two points becomes Z3. Accordingly, Z3 can be an optimal solution when considering the two goals of least cost and shortest time. But this value is an infeasible solution.

$$\min \sum_{a \in A} (c_a^m \cdot q_a \cdot x_a^m + q_a \cdot lc_n^a + q_a \cdot uc_n^a) \quad \ldots(1)$$

$$\text{such that } \sum_{a \in \delta^+(i)} x_a - \sum_{a \in \delta^-(i)} x_a = \begin{cases} 1, \text{if } i = s \\ -1, \text{if } i = t \\ 0, \text{if } i \in V \setminus \{s, t\} \end{cases} \quad \forall i \in V$$

$$\sum_{a \in A} w_a x_a \le W_t$$

$$x_a \in \{0,1\} \quad \forall a \in A$$

$$\min \sum_{a \in A} (t_a^m \cdot x_a^m + lt_n^a + ut_n^a) \quad \ldots (2)$$

$$\text{such that } \sum_{a \in \delta^+(i)} x_a - \sum_{a \in \delta^-(i)} x_a = \begin{cases} 1, \text{if } i = s \\ -1, \text{if } i = t \\ 0, \text{if } i \in V \setminus \{s, t\} \end{cases} \quad \forall i \in V$$

$$\sum_{a \in A} w_a x_a \le W_c$$

$$x_a \in \{0,1\} \quad \forall a \in A$$

c_a^m : Transport cost of transport mode m at the arc a

x_a^m : When transported from arc a by transport mode m, 1 or 0

q_a : Quantity of Cargo at the arc a

lc_n^a : Loading cost of arc a at node n

uc_n^a : Unloading cost of arc a at node n

lt_n^a : Loading time of arc a at node n

t_a^m : Transport time of transport mode m at the arc a

lt_n^a : Loading time of arc a at node n

ut_n^a : Unloading time of arc a at node n

w_a : Constraint at the arc a

W_c : Cost constraint

W_t : Time constraint

Formula (1) is the function to seek the shortest time. It includes not only the traveling time from one node to the next node, but also the shipment time at the departing place, unloading time in the arriving place, and all the transshipment time at the transit places. Formula (2) is the function to seek the least cost. It includes both the traveling cost and loading and unloading costs at the transit places. The constraining conditions of both formula (1) and formula (2) are identical, but in the formula (1) seeking the least cost, the constraining condition "W" is time, and in the formula (2) seeking the shortest time, the constraining condition is a cost.

If the effective area is generated by mathematical model, then a lot of routes will be able to be generated by TNPS. Among these routes, the routes that enter the effective area belong to Pareto solution, but all the other routes out of effective area are to be eliminated. Meanwhile, as shown in the <figure 7>, in order to evaluate each solution inside the effective area, the straight lines' distance from the point Z3 has been used. In evaluation, the weight of time and cost is not 1:1. It can be changed according to the user's requirements.

<Figure 7> shows the results of our experiment, which takes the case of the routes between Busan port to Rotterdam port in Europe. <Table 1>, which is generated from the experiment, shows Pareto solutions for the evaluation of each transportation network. Among them, the shortest one is an optimal alternative. However, as time and cost have different criteria, they have to be normalized as illustrated in the <table 2>.

<Table 1> Results of Pareto solution

Frequency of transshipment	Pareto solution
Twice	(18,167) (20,165) (23,152) (24,140) (27,130) (29,128) (30,120)
Three times	(21,160) (25,138)

<Table 2> Normalized value of time and cost

Frequency of transshipment	Normalized Value
Twice	(0.080, 0.150), (0.090, 0.147), (0.105, 0.124), (0.110, 0.103), (0.125, 0.086), (0.135, 0.082), (0.140, 0.068)
Three times	(0.095, 0.138), (0.116, 0.100)
Z_3	(0.0, 0.0)

(x, y): x: time, y: cost

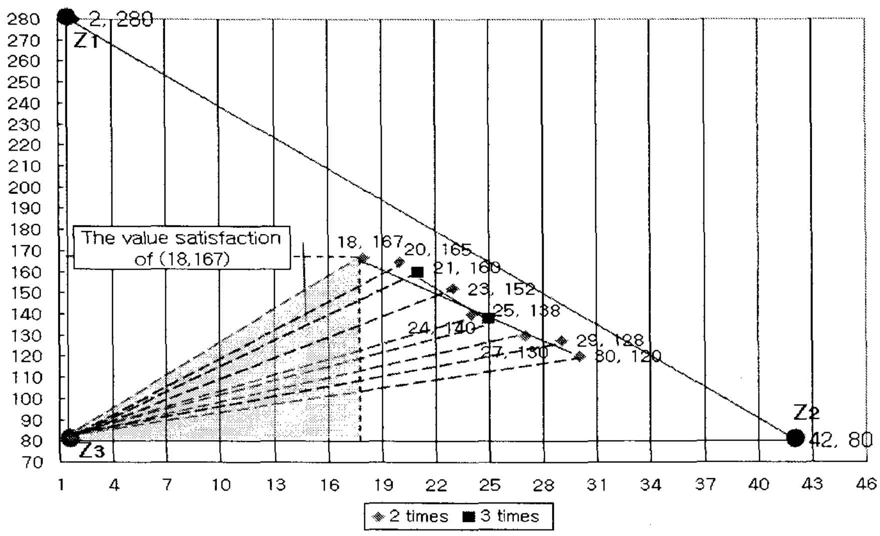
<Table 2> shows the normalized value of each alternative and arbitrary optimal solution Z3. But as time and cost have different sizes, their relative distribution has been described as the values between "0" and "1". <Table 3> illustrates the results of the evaluation on each Pareto alternative based on these values.

<Table 3> Results of evaluation by mathematical model

Frequency of transshipment	Pareto solution	Distance to Z_3

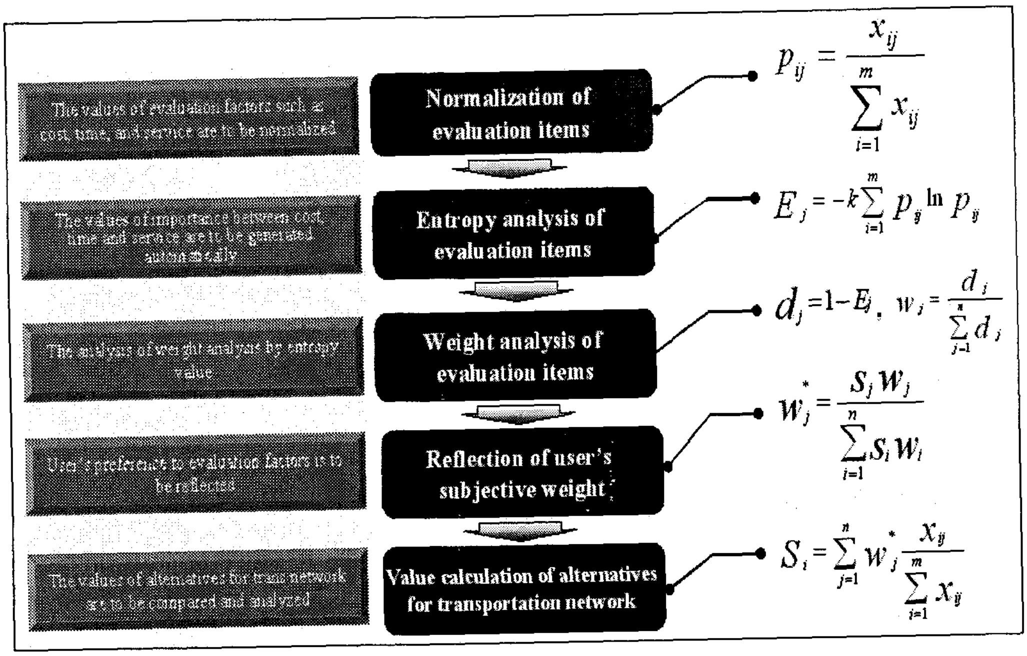
2 times	(18,167)	0.0289
	(20,165)	0.0297
	(23,152)	0.0264
	(24,140)	***0.0227***
	(27,130)	0.0230
	(29,128)	0.0249
	(30,120)	0.0242
3 times	(21,160)	0.0280
	(25,138)	0.0255

<Table 3> shows that the alternative with the value (24,140) is an optimal transportation network.



<Figure 7> Generation of an optimal solution by mathematical model

Secondly, the MADM has been introduced to evaluate the other factors such as port service and transporter's service except time factor and cost factor. MADM is usually used as a decision-making method in case that there are many factors to be considered. Because diverse factors with different criteria have to be evaluated, first of all, those factors have to be normalized for comparison on the basis of the same rule. Also, subjective weight among the evaluation items can be given to find out the optimal alternative that the user wants. In particular, in case of extraordinary cargo transportation, not a routine transportation, the service factors including transporter's capacity have to be considered comprehensively. The evaluation by MADM has been performed as shown in the <figure 8>. First, the evaluation items such as cost, time, and service have been normalized. Then by using entropy method, the weight of each item has been given to each item, and also the user's subjective weight has to be given.



<Figure 8> Process of MADM

The evaluation of transportation networks may be able to be continued. If the user changes his conditions and weight to have another alternative, the evaluation for a new alternative can be made again. This means that the system doesn't determine an optimal transportation network, but by means of mutual cooperation between a user and a system, an optimal network can be found.

Experiments on MADM-based evaluation have been made based on the same data used in the evaluation by mathematical model. Also the evaluation materials on the service level have been taken into consideration. Based on the service level-related data, which have been used by 3PL companies and forwarders over the years, along with the interviews with persons in charge in the field, virtual values have been calculated and applied to the evaluation by MADM. The results of evaluation by MADM are shown in the following <table 4>.

<Table 4> Results of evaluation by MADM

Frequency of transshipment	Pareto solution	Results of evaluation by MADM
	(18,167,5)	0.118
	(20,165,5)	0.109
	(23,152,4)	0.103
2회	(24,140,4)	0.121
	(27,130,5)	***0.135***
	(29,128,3)	0.100
	(30,120,3)	0.110

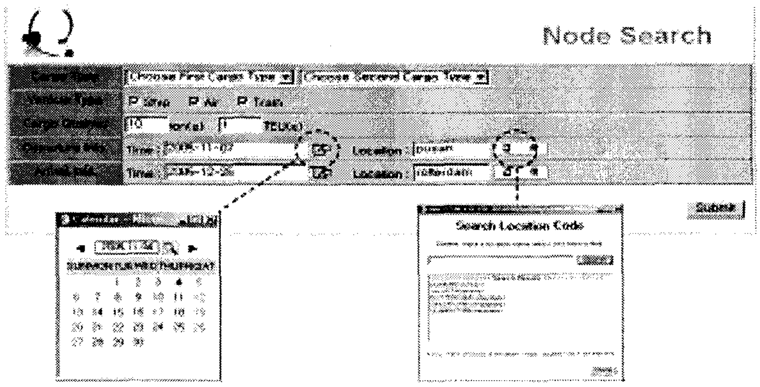
3회	(21,160,5)	0.113
	(25,138,2)	0.090

The evaluation by MADM has shown a different result compared with the evaluation by a mathematical model. In this evaluation by MADA, its value of 0.135 has generated the Pareto solution of (27,130.5), which is considered to be an optimal transportation network. Since a lot of factors such as cost, time, and service influence user's transportation networks, the optimal network can be changed according to the user's priority placed on those factors. In other words, an optimal transportation network cannot be presented by an algorithm, but it can be changed by user's priority. The TNPS developed in this study can effectively satisfy user's requirements.

IV. Case Study

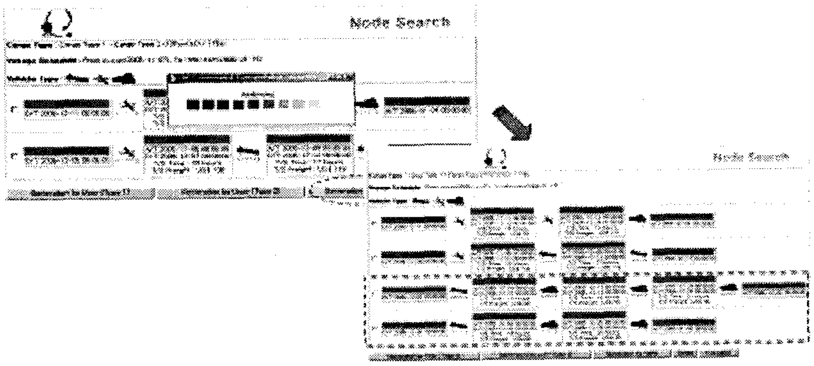
In order to test the validity and practicality of the TNPS, this study has performed a case study in which we have suggested a virtual case of cargo transportation to the person in charge of transportation network planning in the frontline, asking him to make an actual transportation network planning based on the suggested case. For instance, suppose 3PL "A" is in charge of international cargo transportation of the shipper "B", and B's I TEU of container cargo is to be transported from Busan port to Rotterdam port of the Netherlands between November 7, 2005 and December 26, 2005. For this case, by using TNPS, the user has made transportation network planning as follows.

Step 1: Cargo Information Input
First of all, the user of 3PL inputs cargo information.



<Figure 9> Cargo information input interface

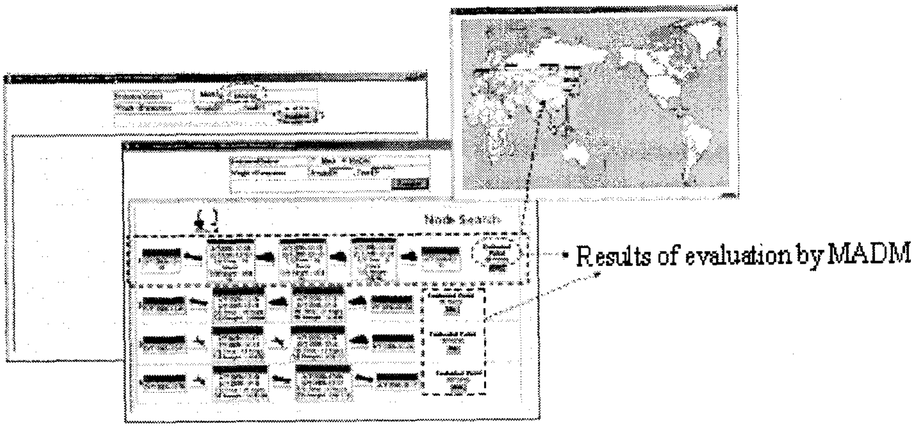
Step 2: Transportation Network Generation
The user generates some transportation networks by using the automatic generation mode. Instead of selecting by himself, the user has wanted TNPS to automatically generate diverse transportation networks.



<Figure 10> Automatic generation screen interface

Step 3: Transportation Network Evaluation

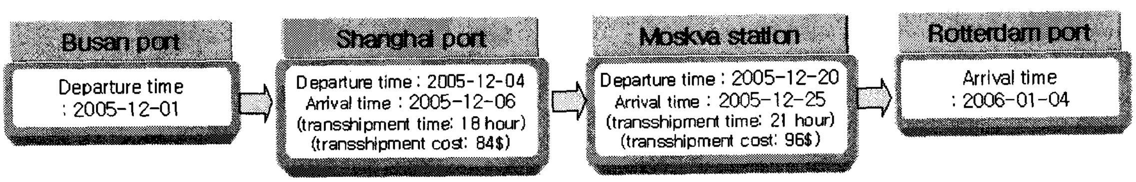
The generated transportation networks have been evaluated by a mathematical model and by an MADM methodology. Both the evaluation in terms of time and cost and the evaluation including service have been performed for comparative analysis.



<Figure 11> MADM-based evaluation process and its results

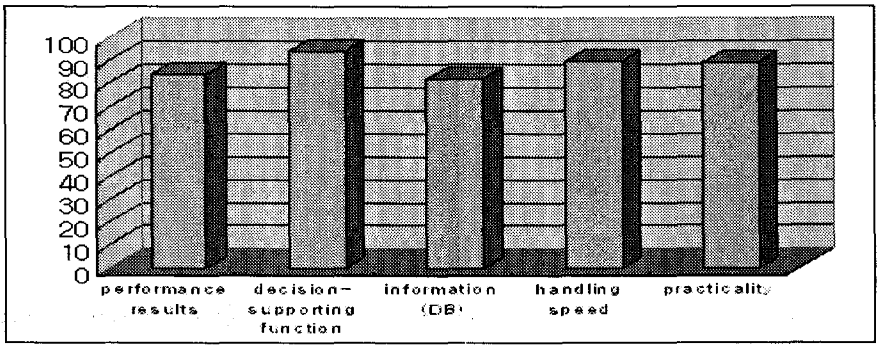
Step 4: Transportation Network Selection

In case of considering time alone, in case of considering cost alone, and in case of using both evaluation methods: mathematical model and MADM, the three cases have been compared and analyzed, and as a result the following transportation network has been selected as shown in the <figure 12>.



<Figure 12> Selected schedule

The transportation network selected by the user is the best one when both cost and time have been considered integratively. The user, who works for a small freight forwarding company, has given more priority to time and cost rather than to service. Meanwhile, in order to raise the validity of our case study, and to find out common requirements of much more users, our case study has covered more persons and more companies. That is, 15 persons and 5 companies have been participated in the case study to upgrade the validity and practicality of TNPS. By using the five-point scale, a user satisfaction test has been conducted in terms of the following five aspects: performance results, decision-supporting function, database, handling speed, and practicality.



<Figure 13> Results of user satisfaction tests

As illustrated in the <figure 13>, the results of the user satisfaction tests is presented in percentage, indicating that most users are showing the satisfaction degree of more than 80% in all aspects of the test items. In particular, the decision-supporting function has shown the highest degree of satisfaction. Handling speed and practicality are showing relatively higher satisfaction, but performance results and database were relatively lower. The reason is that the developed prototype has some degree of limits, and so the results have not shown exceptional things. In fact, the prototype developed for a test has not yet contained enough exceptional information on individual routes, but has some information only on European routes. However, later on users have come to know that the main purpose of TNPS is to help efficiently transportation network planning, not to deal with exceptional things. Furthermore, users have expressed high expectations that TNPS is likely to quantitatively bring on not only profits and cost saving, but also the improvement of job process and job efficiency qualitatively.

V. Conclusion

Focusing on enhancing the competitiveness of third party logistics companies, this study has developed a TNPS. This new system is a decision supporting system that enables 3PL to deliver customer's cargo through an optimal transportation network planning.

Recently, in order to activate 3PL, a lot of efforts are being made emphasizing the importance of offering new logistics services and development of information system. TNPS is a completely new system. There is some decision supporting system for an optimal transportation network planning only within a restricted area. But there is no such system for multimodal transportation on a global basis. In particular, TNPS is not only providing new services but also presenting to the shippers objective evaluation materials on transportation networks, so that customers will be able to put trust in the 3PL. Also by using these materials, 3PS companies will be able to conduct more aggressive marketing activities, eventually bringing a symbiotic effect on both 3PL's and customers. Moreover, it is expected that TNPS will bring job efficiency and cost saving to the 3PL's.

More importantly, in dealing with the problem of an optimal transportation network planning, this study has focused on developing decision supporting system for users, rather than generating an optimal alternative proposal. That is to say, this study has suggested a new approach to find out an optimal alternative proposal. This study judges that what users want is not an optimal proposal suggested by a system, but the decision-supporting materials that enable them to select an optimal alternative.

Acknowledgments

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